



“Modelling vulnerability of coastal ecosystems to land-based mining pollution: a case study from Brazil”

By Rafael A. Magris, Natalie C. Ban, Jose Monteiro

Mining in Brazil is a significant primary industry

Production forecast for several selected minerals: The 2030 National Mining Plan

Product	Un.	2008	2015	2022	2030
Iron Ore	Mt	351	585	795	1,098
Gold	t	55	120	180	200
Bauxite	Mt	26.8	42.3	56.7	79.3

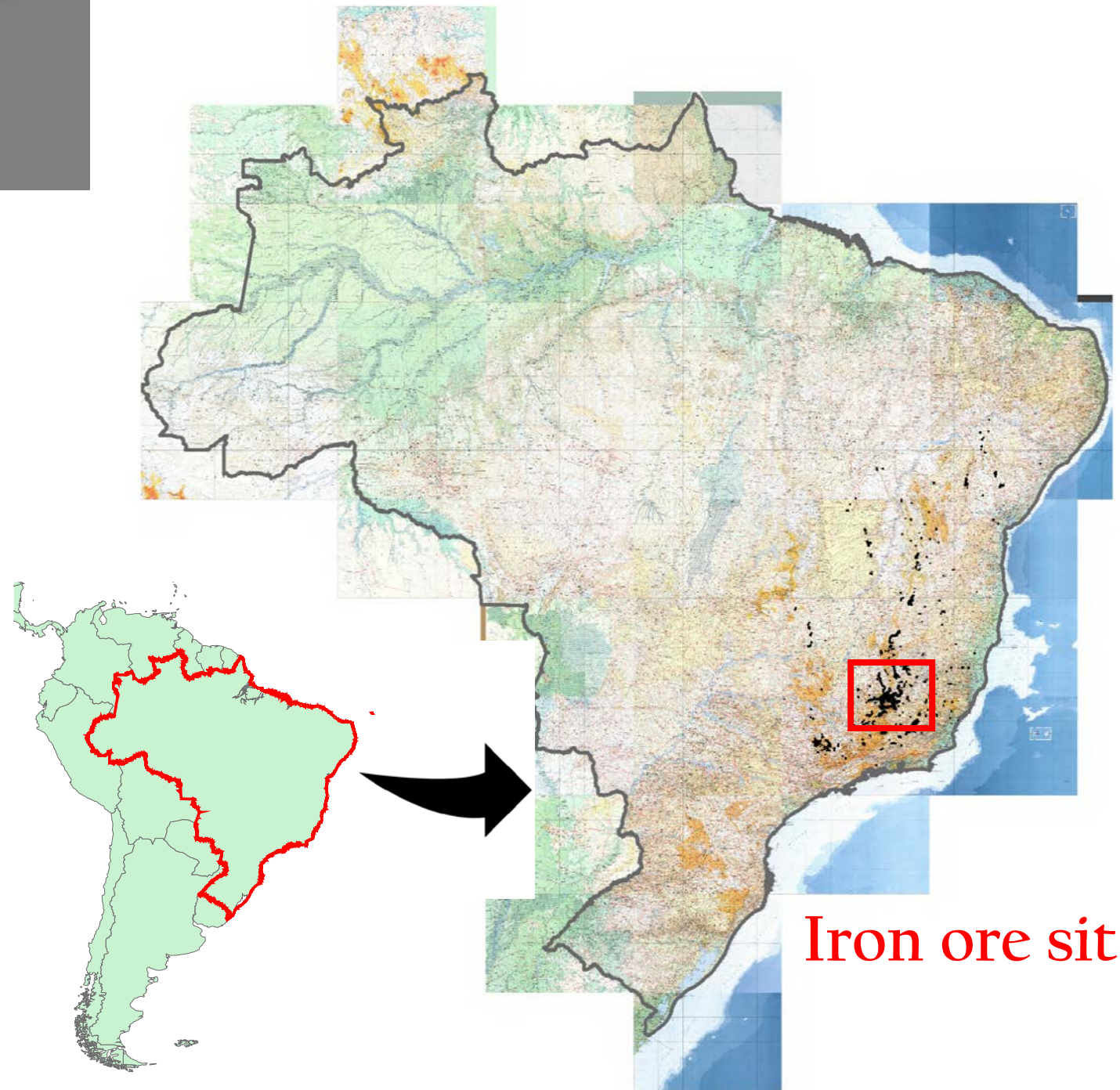
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Iron and associated metals

58% of revenue from mining



Iron ore sites

Environmental impacts of mining

1. Physical loss of habitat



Environmental impacts of mining

2. Disposal of mine wastes



Environmental impacts of mining

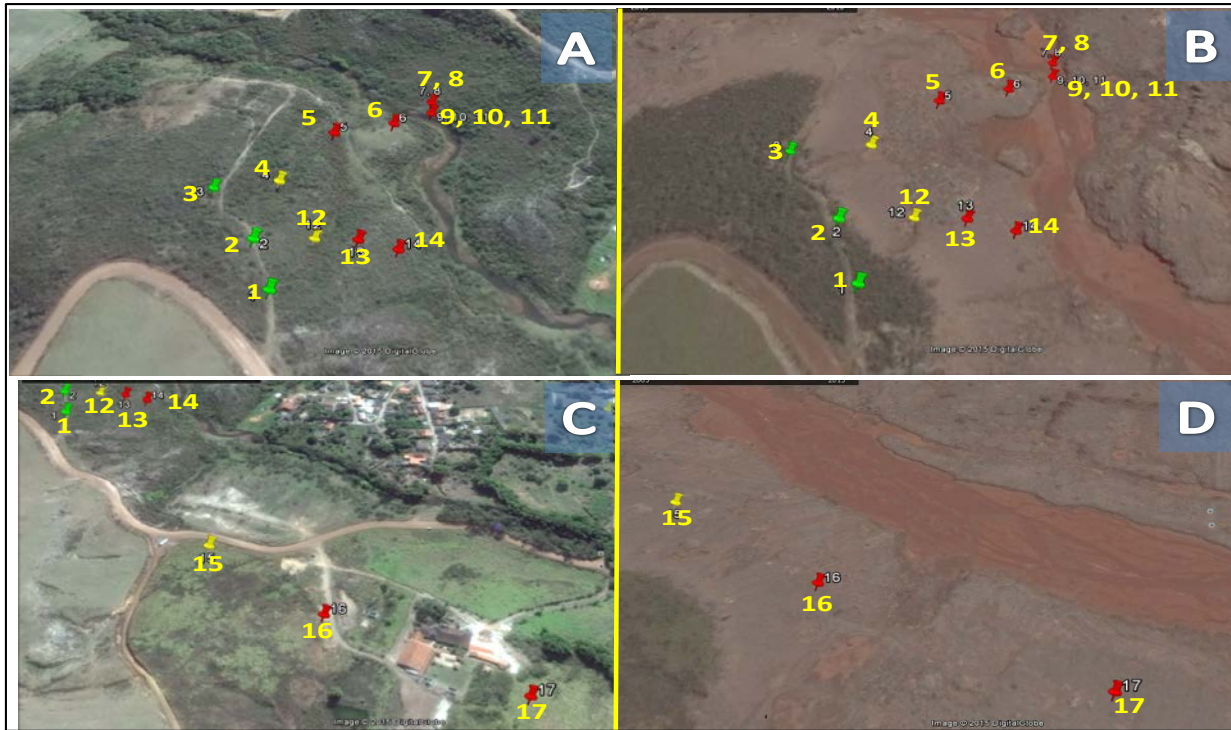
3. Post-mining impacts



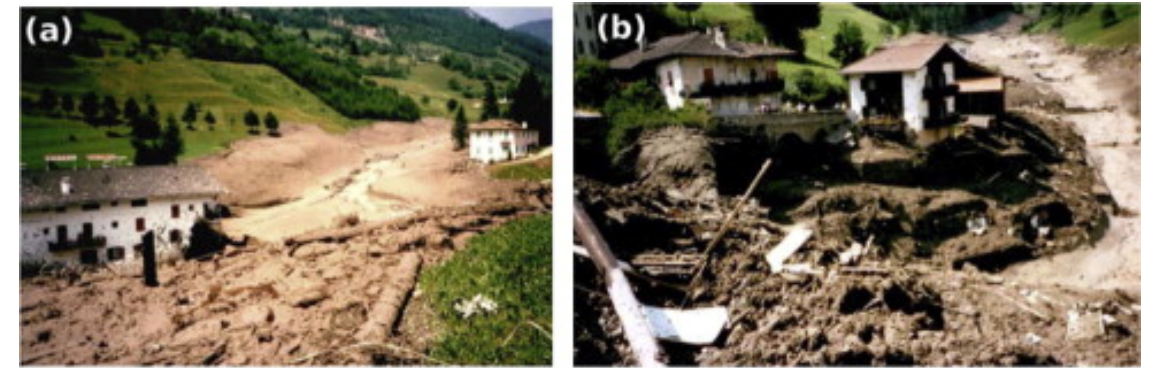
Mining as a source of pollution: tailing dam failures

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Physical loss of habitat



Segura et al. 2016



Kossoff et al. 2014

Mining as a source of pollution: tailing dam failures

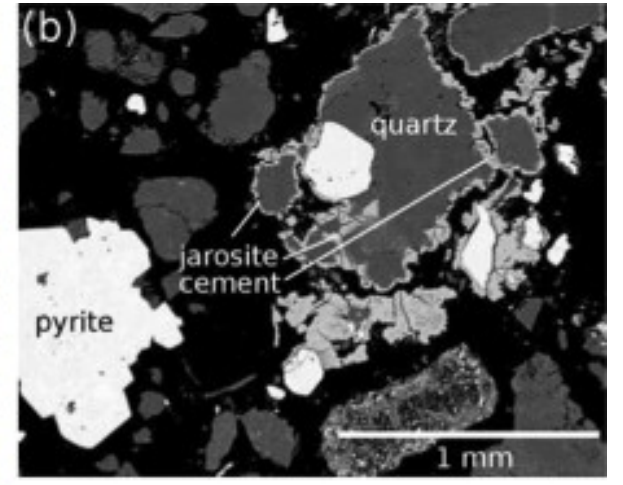
Flooding



Segura et al. 2016

Mining as a source of pollution: tailing dam failures

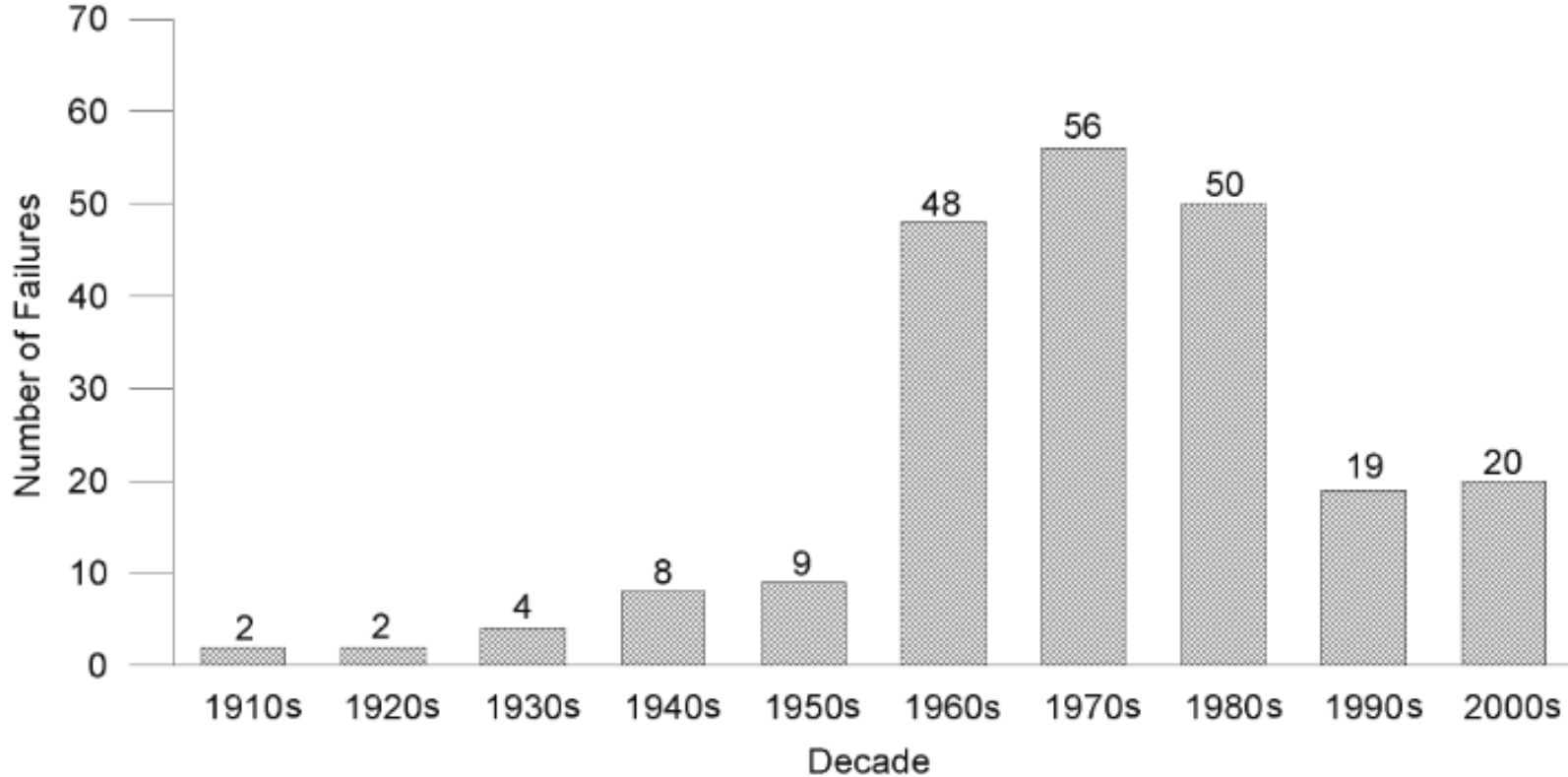
Pollution: Sediments and heavy metals



Kossoff et al.
2014

Mining as a source of pollution: tailing dam failures

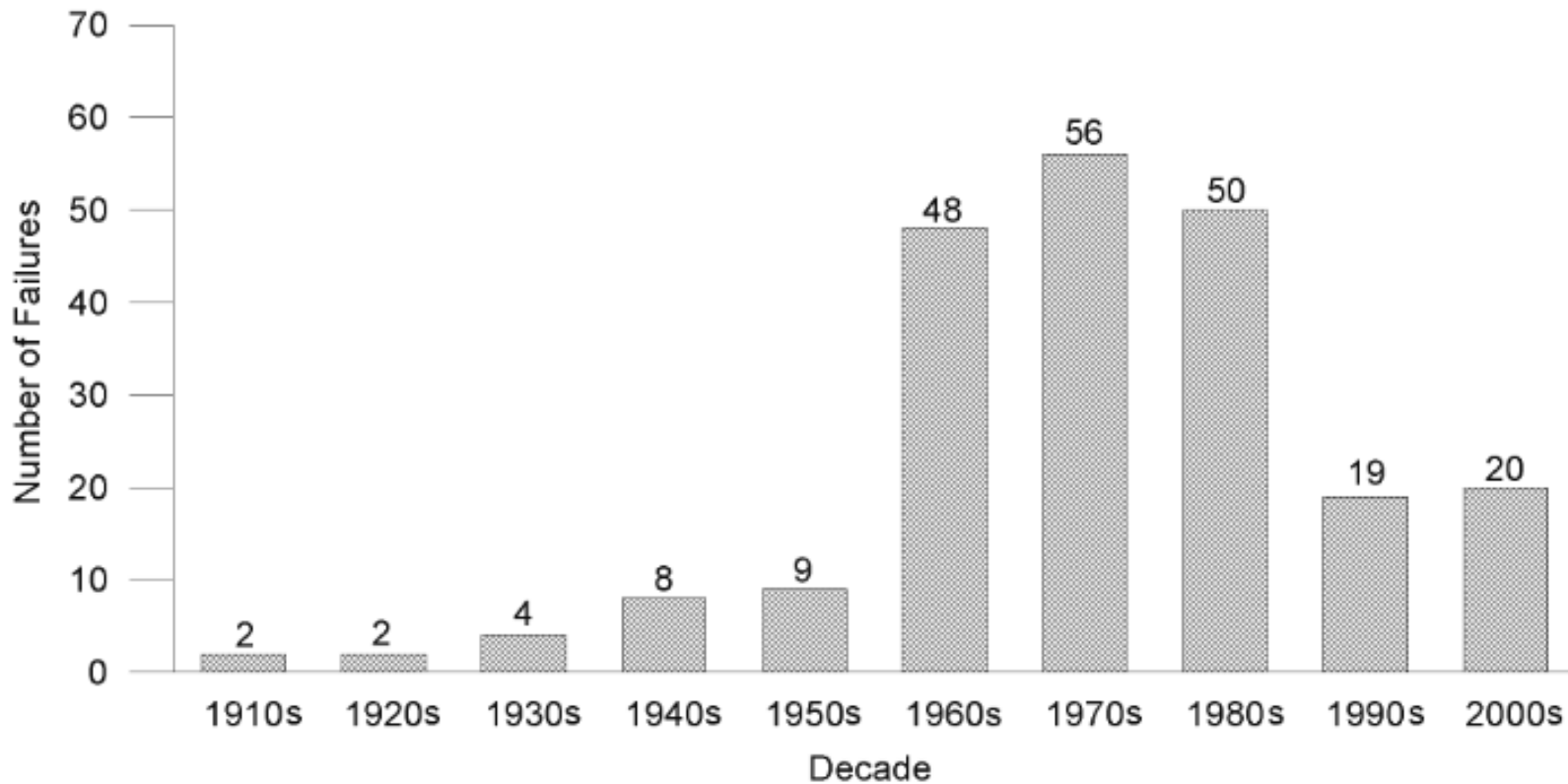
Failure events over time



Mining as a source of pollution: tailing dam failures

Failure events over time

#Slope stability
#Seismic
#Overtopping



Aims of this study

1. Develop a vulnerability model of coastal ecosystems to potential disturbances associated with dam collapse events
2. Provide some evidence for on-ground conservation practices or policies such as identifying tailing dams with increased potential to impact

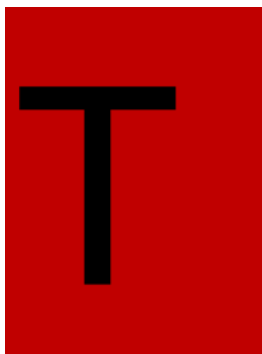
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Study Area

87,400 km²

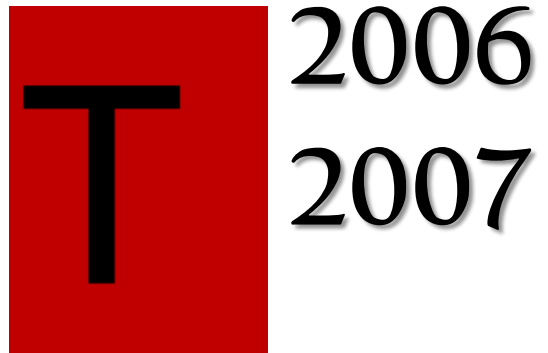
56,500 km²

Study Area



2015

Study Area



Vulnerability framework

Exposure component

Sensitivity component

Vulnerability framework

Exposure component

Hydrological modelling:
end-of-river loads

Suspended
sediment

Metals:
Al and Fe

Sensitivity component

Vulnerability framework

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Coastal transport modelling

Potential areas of
sedimentation =
Expected exposure

Sensitivity component

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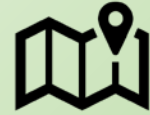
Mapping ecosystem
distribution

Rocky reefs

Coral reefs

Seagrasses

Mangroves



Vulnerability framework

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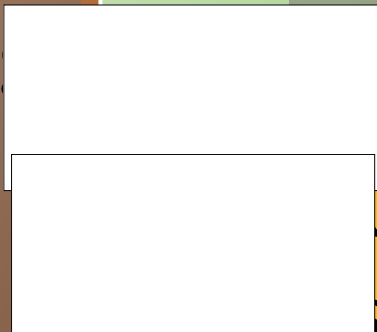
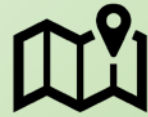
Seagrasses

Mangroves

Meta-analysis for coastal
ecosystems

Suspended
sediment

Contamination
by metals



Exposure (land component): SWAT

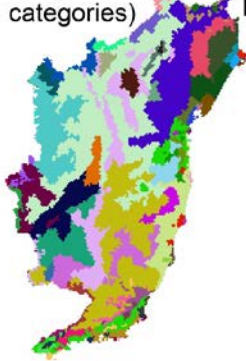
Exposure (land component): SWAT

Watershed characteristics

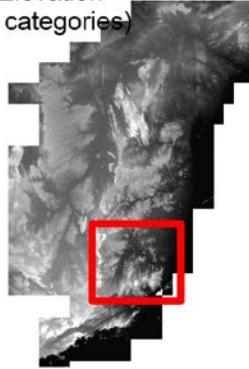
Land Uses
(6 categories)



Soil Types
(11 categories)

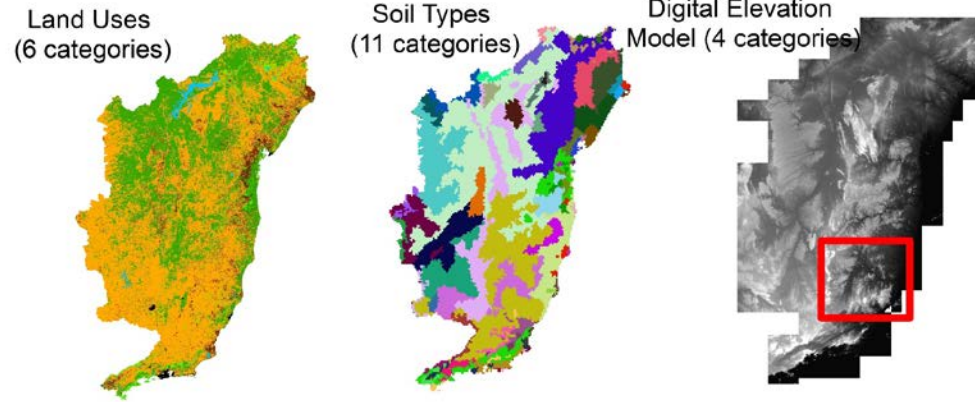


Digital Elevation
Model (4 categories)

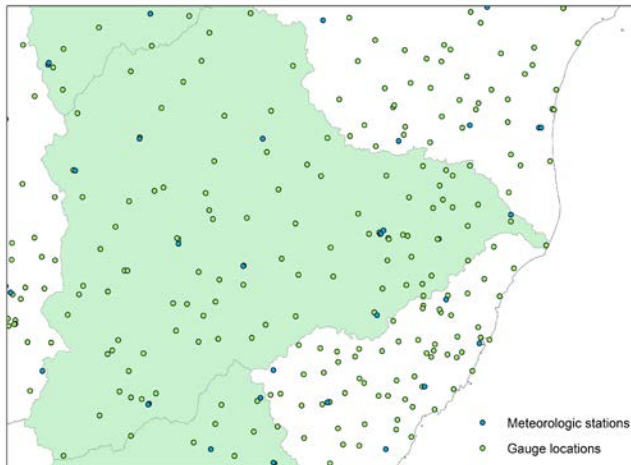


Exposure (land component): SWAT

Watershed characteristics



Weather data



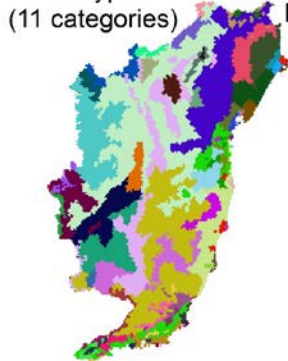
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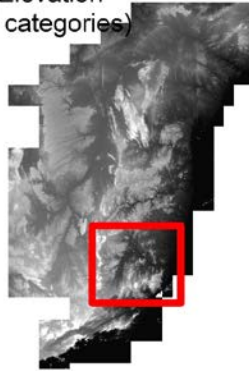
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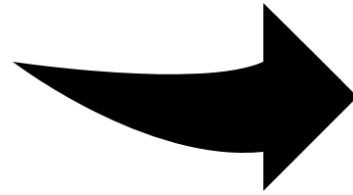
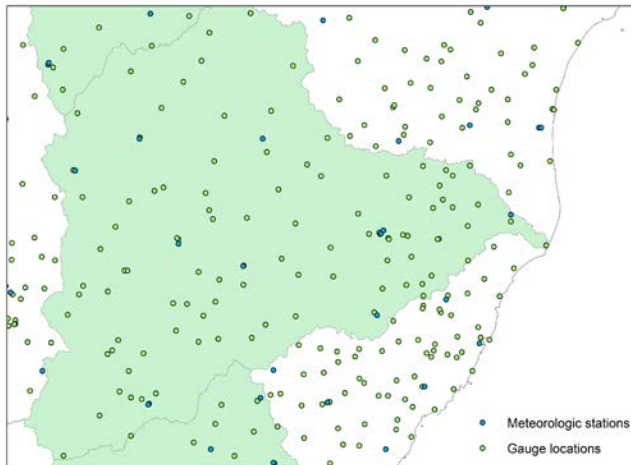
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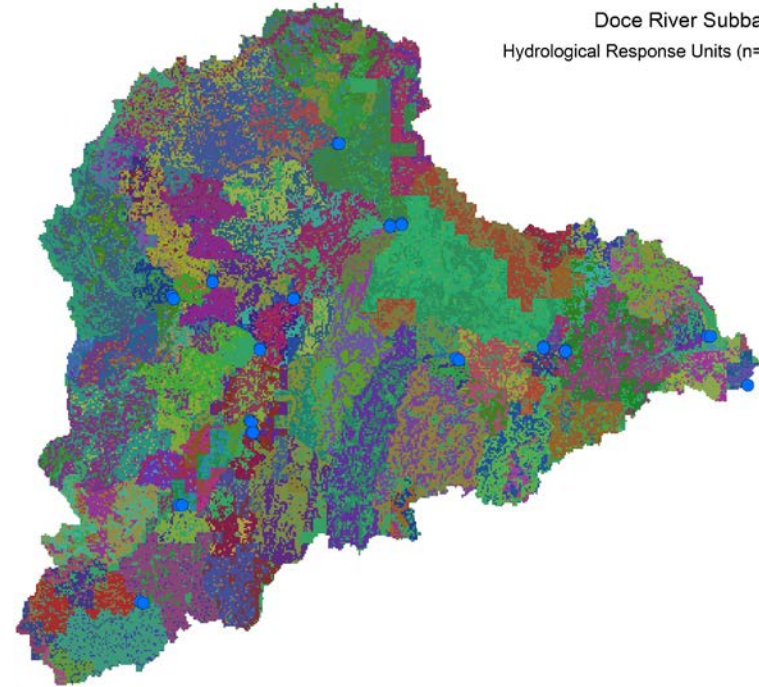
Digital Elevation
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Weather data



Doce River Subbasin
Hydrological Response Units (n=276)



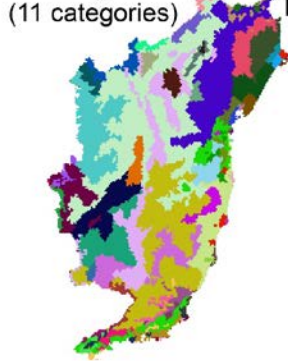
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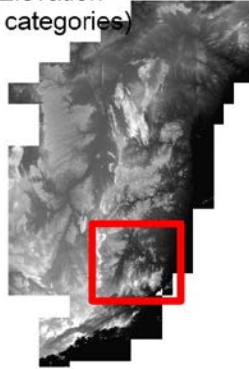
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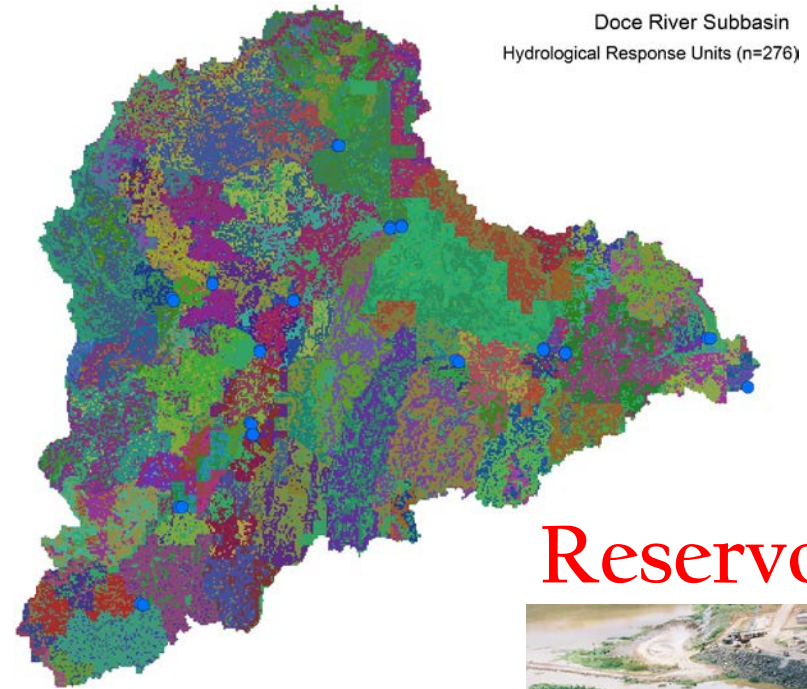
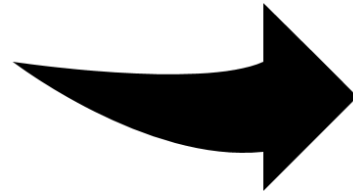
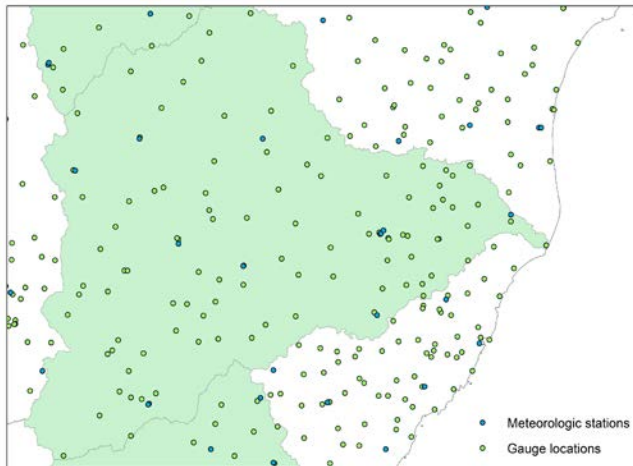
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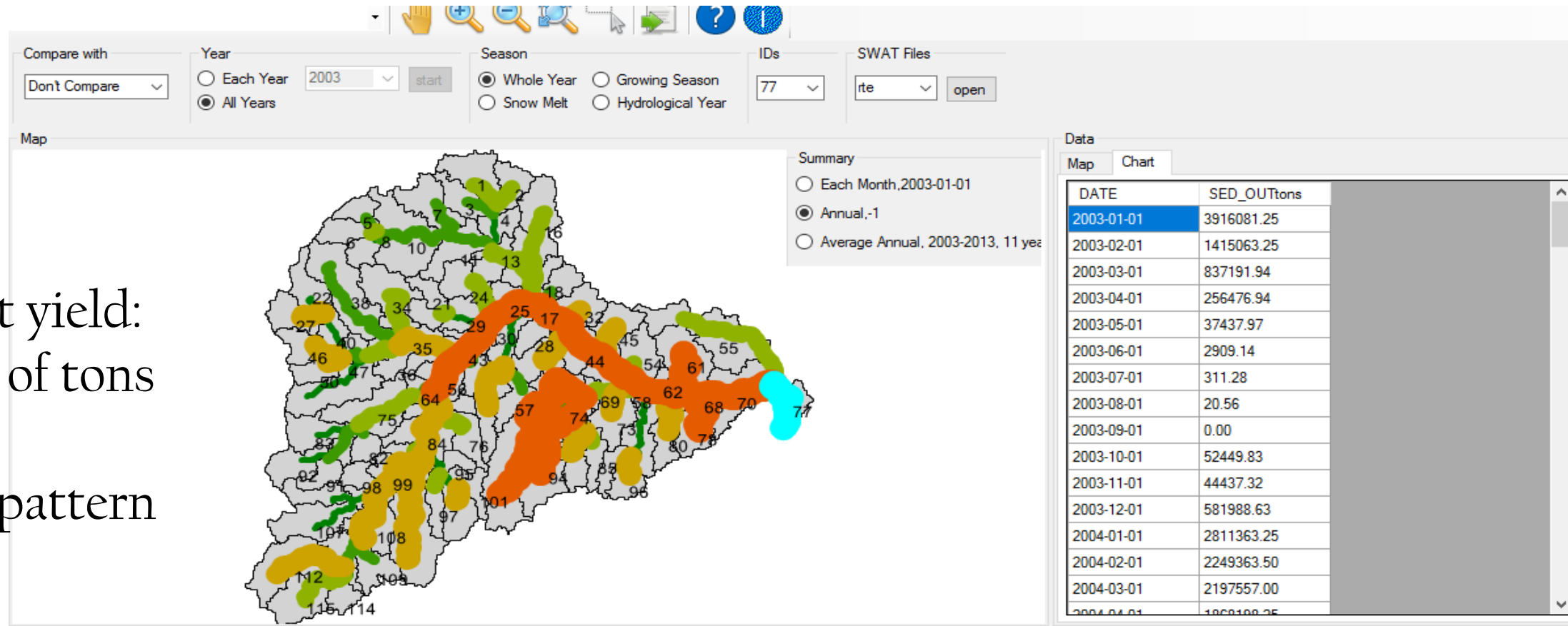
Weather data



Reservoirs

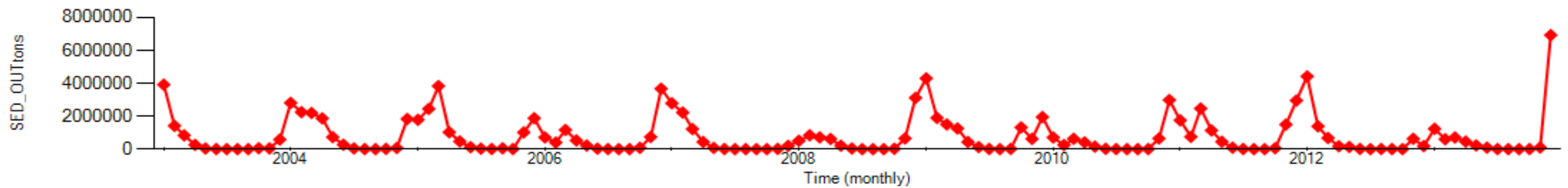


Baseline scenario: Doce River

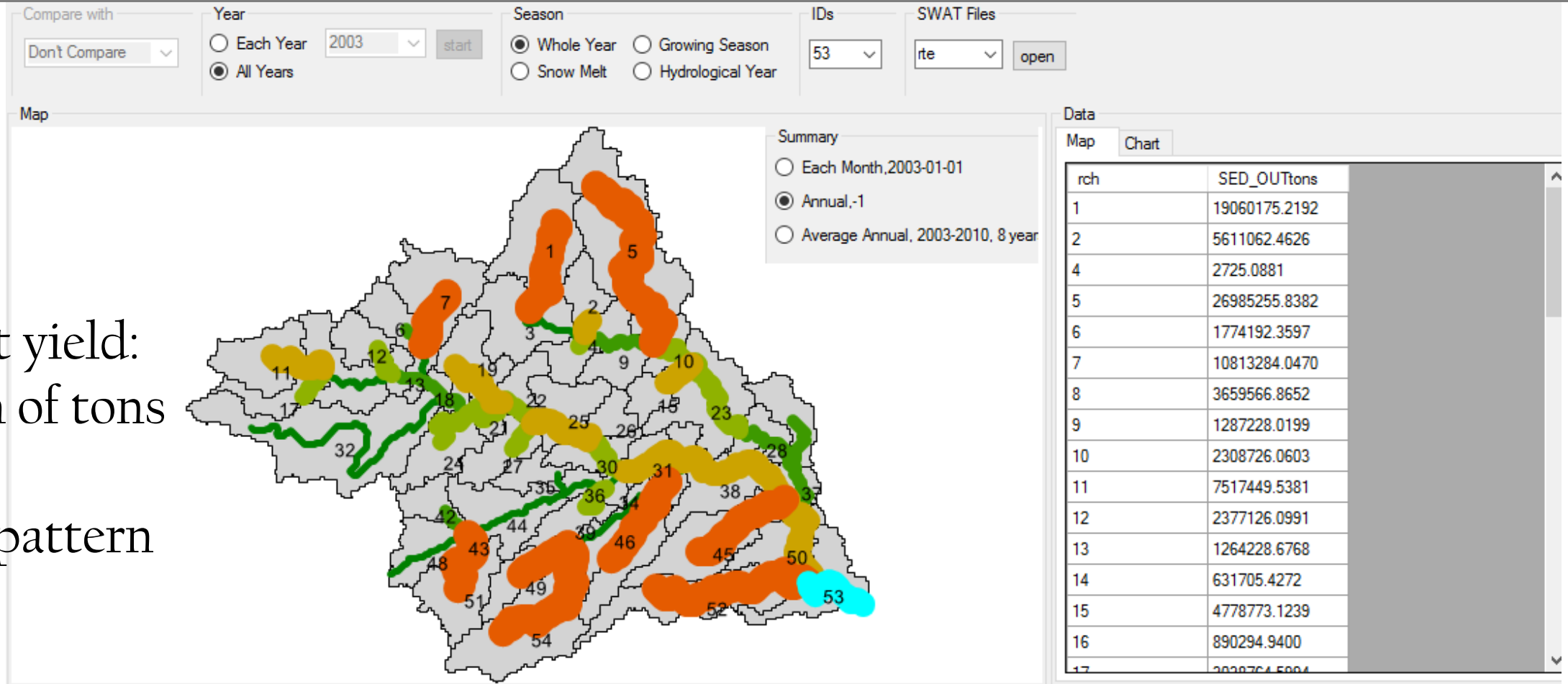


Sediment yield:
~4million of tons

Seasonal pattern

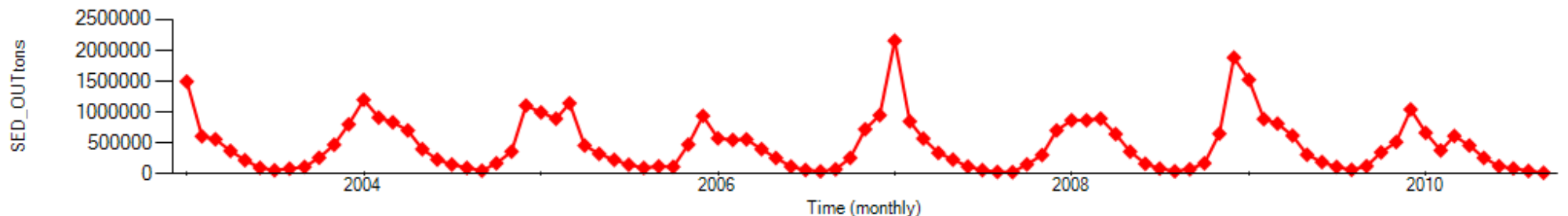


Baseline scenario: Paraíba do Sul River



Sediment yield:
~1.5million of tons

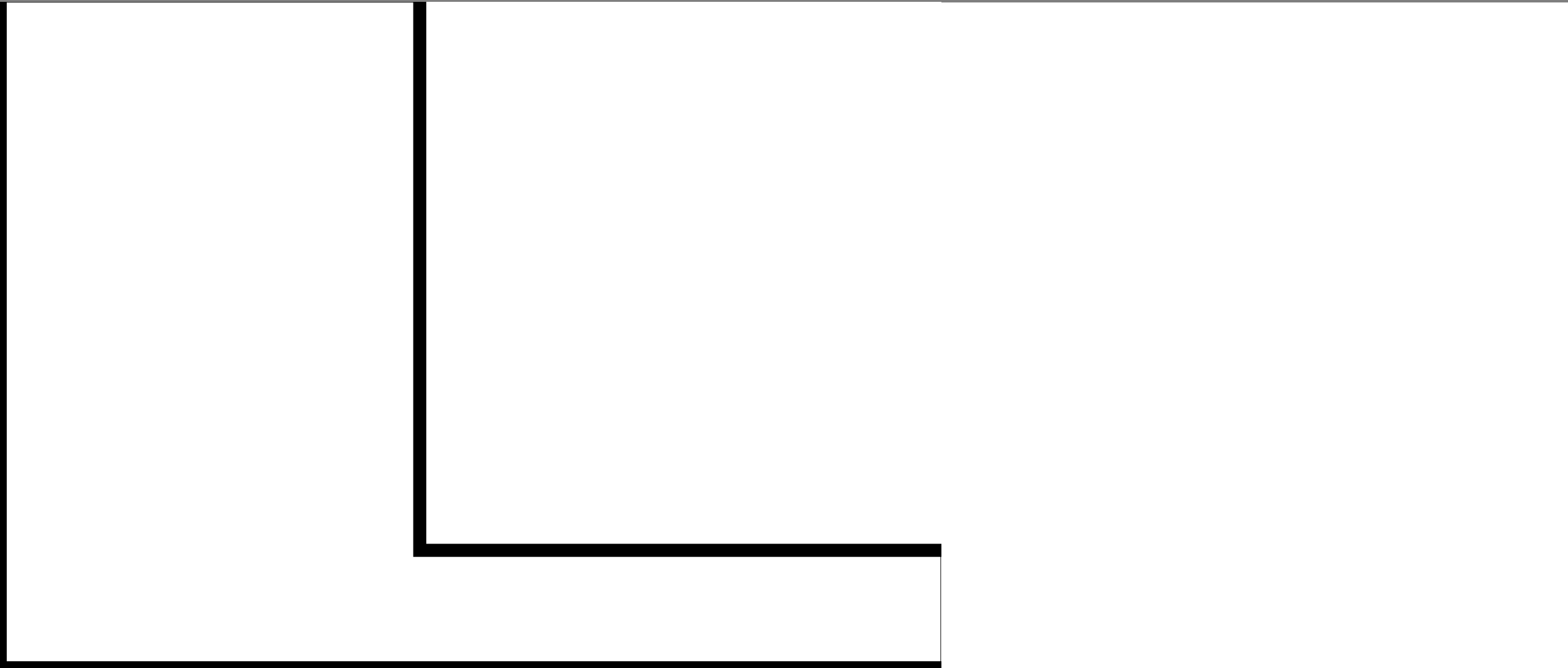
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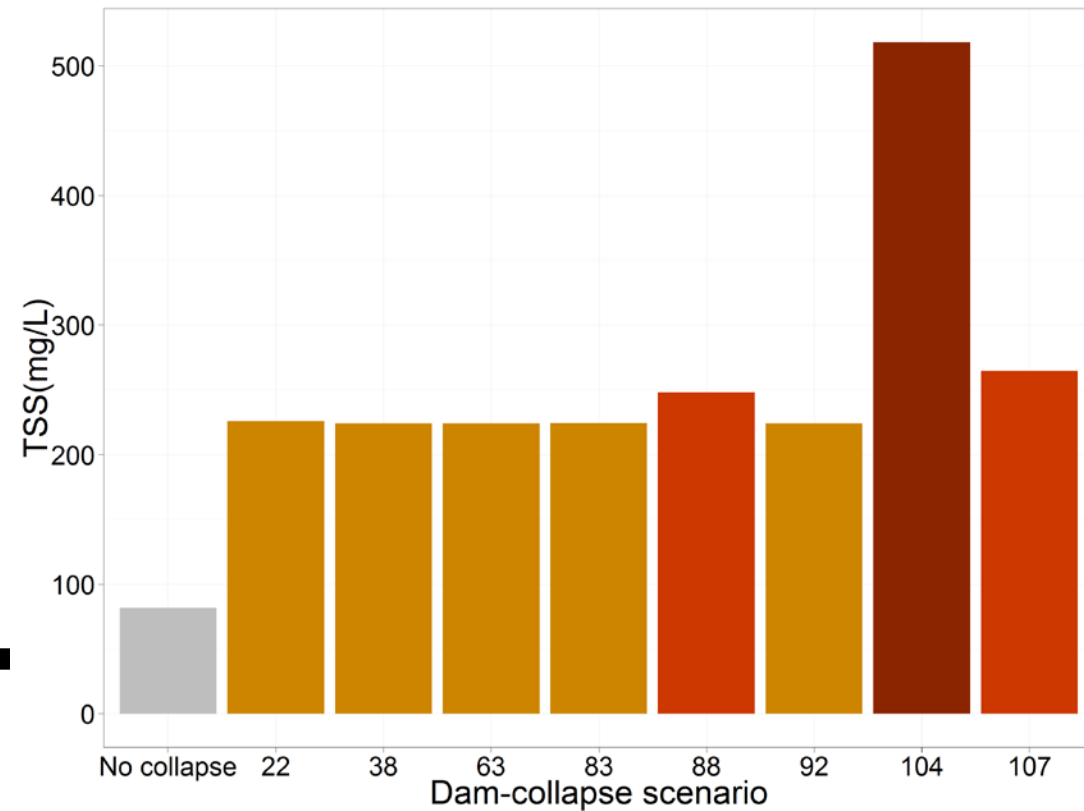
Point
source of
pollution

Dam-collapse
scenarios: 8
largest dams

Dam-collapse scenarios: sediment export increase and concentrations at river mouth (post-disturbance)



Dam-collapse scenarios: sediment export increase and concentrations at river mouth (post-disturbance)



Stage of analysis

1. SWAT parameterisation



2. SWAT calibration and validation



3. Oceanic dispersal model



4. Ecosystem mapping



5. Meta-analysis - review



Current challenges – Advises

1. Calibration for discharge – impact of reservoirs
2. Calibration for sediments – impacts of reservoirs
3. Simulation of heavy metals dispersal



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Thank you!

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